

CLAIMS

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2 1. A method for detecting the occurrence of surge or incipient surge in a
3 centrifugal compressor, the compressor having an inlet passage, an inlet passage
4 wall and an impeller, the method comprising the steps of:

5 operating the centrifugal compressor thereby establishing a fluid flow in
6 the inlet passage; and

7 measuring characteristics of the fluid flow in the inlet passage proximate
8 to the inlet passage wall and proximate to the impeller.

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10 2. A method as in Claim 1 wherein the step of measuring the fluid flow
11 includes detecting a reversal in the fluid flow direction.

12 3. A method as in Claim 1 wherein the step of measuring the fluid flow
13 includes measuring a tangential component to the fluid flow.

14 4. A method as in Claim 1 wherein the step of measuring the fluid flow
15 includes measuring a substantial decrease in the axial fluid flow.

16 5. A method as in Claim 1 wherein the step of measuring the fluid flow
17 includes measuring changes in the fluid flow temperature.

18 6. A method as in Claim 2 wherein the step of measuring the fluid flow
19 includes measuring the fluid flow temperature.

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1 ¶ 7. A method as in Claim 1 further comprising the step of controlling the
2 flow through the compressor.
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1 8. A method as in Claim 7 wherein the step of controlling the fluid flow
2 includes increasing the fluid flow to the inlet passage.
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1 ¶ 9. A method as in Claim 2 further comprising the step of controlling the
2 flow through the compressor.
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1 ¶ 10. A method as in Claim 3 further comprising the step of controlling
2 the flow through the compressor.
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1 ¶ 11. A method as in Claim 5 further comprising the step of controlling the
2 flow through the compressor.
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1 ¶ 12. A method as in Claim 4 further comprising the step of controlling the
2 flow through the compressor.
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1 13. A method as in Claim 1 wherein the step of measuring includes
2 measuring the fluid flow using at least one fluid velocity sensor.
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1 14. A method as in Claim 13 wherein the at least one fluid velocity
2 sensor is attached to the inlet passage wall.
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1 15. A method of detecting surge or incipient surge in a centrifugal
2 compressor, the compressor having an impeller and an inlet passage upstream of
3 the impeller, the method comprising the steps of:

4 operating the compressor, thereby establishing fluid flow through the
5 inlet passage and impeller; and

6 measuring the fluid flow in a recirculation zone in the inlet passage.
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1 16. A method as in Claim 15 wherein the step of measuring the fluid
2 flow includes detecting a reversal in the fluid flow direction.
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1 17. A method as in Claim 15 wherein the step of measuring the fluid
2 flow includes measuring a tangential component to the fluid flow.
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1 18. A method as in Claim 15 wherein the step of measuring the fluid
2 flow includes measuring a substantial decrease in the axial fluid flow.
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1 19. A method as in Claim 15 wherein the step of measuring the fluid
2 flow includes measuring changes in the fluid flow temperature.
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1 20. A method as in Claim 16 wherein the step of measuring the fluid
2 flow includes measuring changes in the fluid flow temperature.
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1 21. A method as in Claim 15 further comprising the step of controlling
2 the flow through the compressor.
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1 22. A method as in Claim 21 wherein the step of controlling the fluid
2 flow includes increasing the fluid flow to the inlet passage.

1 23. A method as in Claim 16 further comprising the step of controlling
2 the flow through the compressor.

1 24. A method as in Claim 20 further comprising the step of controlling
2 the flow through the compressor.

1 25. A method as in Claim 21 further comprising the step of controlling
2 the flow through the compressor.

1 26. A method as in Claim 15 wherein the step of measuring includes
2 measuring the fluid flow using at least one fluid velocity sensor.

1 27. A method as in Claim 26, the inlet passage having an inlet passage
2 wall and wherein the at least one fluid velocity sensor is attached to the inlet
3 passage wall.

1 28. A method for detecting the occurrence of surge or incipient surge in
2 a fluid flow system, the fluid flow system having a centrifugal compressor in
3 fluid communication with an upstream fluid conduit and a downstream fluid
4 conduit, the centrifugal compressor having an inlet passage and an impeller, the
5 method comprising the steps of:

6 operating the compressor, thereby establishing fluid flow through the
7 inlet passage and impeller; and

8 measuring the fluid flow in a recirculation zone in the inlet passage.

1 29. A method as in Claim 28 wherein the step of measuring the fluid
2 flow includes measuring a reverse in the fluid flow direction.

1 ²30. A method as in 28 wherein the step of measuring the fluid flow
2 includes measuring a tangential component to the fluid flow.
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1 ³31. A method as in Claim 28 wherein the step of measuring the fluid
2 flow includes measuring a substantial decrease in the axial fluid flow.
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1 ⁴32. A method as in Claim 28 wherein the step of measuring the fluid
2 flow includes measuring changes in the fluid flow temperature.
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1 ⁵33. A method as in Claim 28 further comprising the step of controlling
2 the flow through the compressor.
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1 34. A method as in Claim 33 wherein the step of controlling the fluid
2 flow includes increasing the fluid flow to the inlet passage.
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1 ⁶35. A method as in Claim 29 further comprising the step of controlling
2 the flow through the compressor.
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1 ⁶36. A method as in Claim 30 further comprising the step of controlling
2 the flow through the compressor.
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1 ⁶37. A method as in Claim 31 further comprising the step of controlling
2 the flow through the compressor.
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2 ⁶38. A method as in Claim 32 further comprising the step of controlling
3 the flow through the compressor.
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1 39. A method as in Claim 28 wherein the step of measuring includes
2 measuring the fluid flow using at least one fluid velocity sensor.

1 40. A method as in Claim 39, the inlet passage having an inlet passage
2 wall and wherein the at least one fluid velocity sensor is attached to the inlet
3 passage wall.

1 41. A method as in Claim 28 wherein the fluid flow system
2 comprises a gas pipeline.

1 42. A method as in Claim 29 wherein the step of measuring includes
2 measuring changes in the fluid temperature.

1 43. An apparatus for detecting the occurrence of surge or incipient surge
2 in a centrifugal compressor, the apparatus comprising:
3 a centrifugal compressor having an inlet passage, an inlet passage wall and an
4 impeller; and
5 at least one sensor for measuring fluid flow proximate to the impeller and
6 proximate to the inlet passage wall.

1 44. An apparatus as in Claim 43 wherein at least one sensor is a fluid
2 velocity sensor.

1 45. An apparatus as in Claim 43 wherein at least one sensor is capable of
2 measuring a reversal in fluid flow direction.

1 46. An apparatus as in Claim 43 wherein the sensor is capable of
2 measuring a tangential component of fluid flow.

1 47. An apparatus as in Claim 43 wherein at least one sensor is a
2 temperature sensor.

1 48. An apparatus as in Claim 44 wherein at least one sensor is a
2 temperature sensor.
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1 49. An apparatus as in Claim 43 wherein the at least one sensor is
2 attached to the inlet passage wall.
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1 50. An apparatus as in Claim 43 further comprising a means of
2 controlling the fluid flow through the centrifugal compressor.
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1 51. An apparatus as in Claim 44 further comprising a means of
2 controlling the fluid flow through the centrifugal compressor.
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1 52. An apparatus as in Claim 45 further comprising a means of
2 controlling the fluid flow through the centrifugal compressor.
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1 53. An apparatus as in Claim 46 further comprising a means of
2 controlling the fluid flow through the centrifugal compressor.
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